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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY—BULLETIN No. 49.
L. O. HOWARD, Entomologist.

REPORT

ON THE

HABITS OF THE KELEP, OR GUATEMALAN COTTON-BOLL-WEEVIL ANT.

By O. F. COOK,
Botanist in Charge of Investigations in Tropical Agriculture, Bureau of Plant Industry.

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HABITS OF THE KELEP, OR GUATEMALAN COTTON-BOLL-WEEVIL ANT.

The kelep[a] was discovered on the cotton April 20, 1904, in Alta Vera Paz, Guatemala, and its efficiency as a destroyer of the Mexican cotton boll weevil (*Anthonomus grandis* Boh.) was demonstrated the following day. It was immediately appreciated, of course, that such an insect would be of value in Texas, providing that it could be colonized and would thrive in that State, and that it had no noxious habits. To the solution of these questions all subsequent study of the species has been directed.

Immediate practical use was also made of these observations of habits and life history. The ant has been brought to Texas in healthy, vigorous condition, notwithstanding injunction proceedings and other unavoidable delays, which lengthened the period of travel and captivity to more than a month. Of about 4,000 ants, in 89 colonies, scarcely more than a dozen died during the voyage, and half of these were in a single colony which was for a time deprived of a queen. The loss, too, was made good many times over by the emergence during the voyage of numerous ants from pupæ which had been collected and placed in the cages with the mature insects.

While the adult worker ants expose themselves freely to dry air and sunlight, the chief factor in the successful transportation of the colonies has been the maintenance of adequate moisture in the cages by means of artificial nests constructed of earth and stones, carefully built in to form underground chambers not to be shaken down by the jarring unavoidable in steamboat and railroad travel. It was fortunate, perhaps, that the weevil ant was quite unknown when we left the United States, for our outfit included nothing in the way of bell jars, glass plates, and other laboratory appliances recommended by Lubbock and other investigators of ants. Much time might have been wasted with these complicated contrivances which would at best have been far less suited to our purposes than the very simple means to which necessity compelled a resort. For this ant, at least, the stone and

[a] This is the name of the cotton-protecting ant in the Kekchi language of Alta Vera Paz, Guatemala. The word has no other meaning or derivation, but appears to have come down from ancient times, when a higher agricultural civilization existed in this region than that found by the Spaniards. The accent is on the second syllable, and the first sounds as though written *kay*.

earth nests built at the bottom of glass jars, with the lower half protected from the light by closely wrapped thick paper, and closed above by a piece of cloth, leave little to be desired. Many of the colonies adopted the artificial nests without change, or have even carried out the few particles of earth which accidentally fell in while the chambers were being constructed for them. Others have brought in earth and remodeled their apartments and are now living in chambers of practically the same size and shape as in their own nests. They have ceased to be disturbed by the occasional removal of the paper cup from the bottom of their cage, and all the operations of the colonies can be observed under conditions altogether favorable.

It is not intended, however, to enter at this time upon detailed accounts of the interesting domestic behavior of the ants, but rather to give what might be called a biological outline of their activities, from which it may be possible to understand something of their place in nature and of their probable utility in agriculture.

One of several minor agricultural virtues of these ants lies in the fact that they dig no large chambers or passages which can serve as pitfalls for men or farm animals, as do many other kinds, including the leaf-cutting ant of southern Texas, which the cotton planters are attempting to exterminate at much expense. The nest of the kelep is a simple burrow, extending from 1 to 3 feet into the ground, and consists of from three to six small chambers, with connecting galleries. The passageways are about a quarter of an inch in diameter and the chambers from 1 to 3 inches broad and half or three-fourths of an inch high, with level or slightly sloping floors and broadly arched roofs. The queen, with some of the eggs and younger larvæ, is generally to be found in the lowest chamber, but the pupæ in their cocoons are usually near the top and the remainder of the smaller larvæ and eggs lower down. In addition to the chambers inhabited by the ants there are in each nest one or more cavities for the storage of the hard parts—the bones, as it were—of the insects which the colony has captured and eaten. Heads, legs, wings, and other fragments of insects of many kinds, including the boll weevil, are here packed indiscriminately together. The mass is often penetrated by a network of delicate roots, and is the home of several small animals which commonly find shelter in the nests of the keleps: a snail, a worm, a mite, a Podurid, and a thysanuran. A hymenopterous insect was also obtained, which is probably a parasite of the ants.

The habit of preserving this useless débris is rendered the more curious by the fact that dead ants seem not to be included in the collection, but are carried out of the nest, as is the general custom among bees and other related insects. It was thought at one time that some of the captive colonies were resorting to cannibalism, since some dead ants were found pulled in pieces like the insects which had

been eaten, but this may have resulted from the prolonged efforts of the living ants to carry the dead out of the nests. When the insects were being liberated at Victoria after a month of captivity, almost the first thing they did was to bring out their dead ants and carry them as far from their nests as the boundaries of their inclosures would permit.

The extremely slight mortality of the ants during the journey is an evidence, certainly, of considerable hardiness. The unexpectedly good result was probably due also, in a measure, to the fact that the insects were transported during the rainy season when the atmospheric humidity was high and the soil in the cages did not dry out rapidly. The margin of safety is evidently a rather narrow one. If the soil is too wet the insects forsake their chambers and crowd together at the surface. When this was noticed the cloth covers were removed to give more air and permit more rapid evaporation. Too great dryness, however, is a much more serious danger. Unless the color of the soil be carefully watched the first intimation of difficulty is likely to come in the form of dead ants. The danger could be lessened, of course, by increasing the quantity of soil in the cages, but this would have the disadvantage of additional bulk and weight, important considerations where transportation is so difficult as in Guatemala.

It seemed possible when the first report was sent in, that the very limited distribution of the ants might be due to some inability on their part to dig in other than the very loose shale soil which covers the particular slopes specially preferred by the insects, according to the belief of the Indians. Later, however, the ants were found in somewhat different situations, and even on level bottom lands, though such are very rare in that part of Guatemala. Considerable diversity of soil was also revealed during the excavations made in capturing the colonies brought to the United States. Furthermore, another way was found of explaining why the ants have so limited a range. It is only on these very loose soils that weeds can be pulled easily, and hence it is only these which can be cleared without burning. A nearly continuous cultivation can be maintained, which is very exceptional under Indian methods of agriculture. The cotton is planted, too, during the latter half of October—a very rainy period when burning is impracticable, so that the ants are not destroyed, as must happen in the clearing of land for corn, beans, and other crops. If these considerations have the supposed bearing, it is not impossible that in the United States, where the land is cultivated more continuously, the ants may multiply and extend their boundaries much more rapidly than they have been able to do in Guatemala.

Every practicable effort was made in Guatemala to find the ants in other localities more accessible than the remote and mountainous district where they were first discovered and from which the caged insects

had to be brought out by Indian carriers. None of the keleps were found, however, in other parts of the country, and the probability of their existence elsewhere seems small in view of the fact that no other field cultures of cotton exist in the neighboring regions, although the natural conditions are generally favorable and many attempts have been made, some on a very large scale. In a few instances a satisfactory crop was obtained the first year before the weevils had time to multiply, and expectations were aroused which only deepened the subsequent disappointment. One very small field of cotton in the Polochic Valley, below Tucuru, was said to be 4 miles from any other plants, but the weevils had found it before the crop ripened. There are rumors of the existence, in Mexico, of tree cottons which are resistant to the boll weevil, but in Guatemala these suffer quite as much as the smaller kinds. Large trees often failed to furnish a single uninjured boll as a specimen for our collection of varieties. The wish to find the protecting insects nearer home has been echoed by many newspaper accounts claiming the existence of the same or similarly useful ants in various parts of Texas, but thus far none of these reports has proved to be based on fact. The kelep is as yet the only ant known to attack and destroy healthy adult boll weevils, just as the cotton grown with the protection of the ants is, so far as known, the only field culture permanently maintained in the weevil-infested regions of Central America.

It was feared at first that the keleps would not be able to excavate nests in other than very loose and granular soils, and particularly that they might fail to penetrate hard and tenacious subsoils like those which underlie some of the cotton fields about Victoria. It seems, however, that these offer no special difficulties for the ants. Some of the buried colonies are bringing up earth from a depth of about 18 inches, and in experimental nests constructed of the tough Texas soil the ants have given ocular demonstration of their power to dig out passageways. The nest of a colony which has been in the ground at Victoria for a week shows, on being dug out, a nearly vertical gallery, with a depth of 14 inches, and the usual lateral chambers. Whether the ants will survive the floods to which many of the level cotton lands of Texas are subject, is one of the questions still to be answered. In Guatemala they are accustomed to very heavy rains which thoroughly saturate the soil, but the drainage is excellent. Possibly, however, the impervious nature of some of the Texas subsoils may afford protection by holding air in the nests.

Another equally practical question is frequently asked by planters who call to see the ants. Will not plowing and cultivation destroy the nests and drive the insects from the cotton fields? As they burrow to a depth of from 1 to 3 feet, the shallow plowing customary in Texas will cut off only the passage leading to the surface,

and this the ants will undoubtedly be able to renew in a few hours. No injury need be anticipated on this score, except the loss of the few individuals actually stepped on and crushed. Where the surface soil is loose the ants are careful to start their nests against some rigid object, often at the base of the cotton plant itself, and follow the root down 2 or 3 inches where a more moist and firm material can be reached. The frequency with which this occurred in Guatemala may indicate that the ants transfer their nests to the vicinity of the cotton after it has begun to grow. There was no indication that the making of the burrows injured the plants, but, if anything, the reverse; at least the largest ant colonies were dug out where the cotton had flourished best. General reasoning would also suggest that the slight opening of the soil about the plant would be as likely to benefit as to injure it. Nothing was found to indicate that the roots of the cotton or any other plant are attacked by the ants. They may gnaw off a small root which interferes with their operations, but they disturb the soil so little that such damage must certainly be extremely slight and in complete contrast to the extensive injuries often done by the large red ants (*Pogonomyrmex barbatus*) native in Texas, which permit nothing to grow within an area of several square yards surrounding the entrance of their nest.

Like the human inhabitants of tropical countries, the ants have the habit of taking a siesta. When the weather is clear and hot they are much less numerous upon the cotton plants in the middle of the day than in the morning or evening, and in the longer days and drier climate of Victoria a tendency to lengthen this period of retirement to the underground nest is already evident. That the strong sunlight and heat are distasteful to the ants is easily proved by alternately shading and exposing the entrance of the nest. The ants appear promptly when there is shade and seek their subterranean shelter when it is withdrawn. The fact that the ants are thus quiescent in the middle of the day when, according to Messrs. Hunter and Hinds, most of the weevil injuries are inflicted, might seem to interfere with their utility. But apart from the poetic justice of having the weevil caught in the act of damaging the cotton, all purposes would be served as well or better if it were disposed of in the evening or the morning before. It seemed in Guatemala that the weevils, as well as the ants, were more numerous in the earlier and later hours of the day; at least they were easier to find. In rainy or cloudy weather more ants remain on the cotton during the day.

The cotton which they protect in Guatemala is an annual variety. The crop is harvested in May and the old plants pulled up to make room for the development of peppers, which it is customary to plant among the cotton, to ripen somewhat later. The ants very rarely

climb the pepper plants, but weevils were in a few instances found roosting upon them—a safer place, apparently, than upon the cotton.

While most ant colonies have only one queen, several were found with larger numbers, usually two or three, but in one case six and in another fifteen. Queens occasionally retain one or both of their wings, and when the colony with the fifteen queens was captured several of them had wings, which were lost later. It was thought that these queens might be young and unfertilized, but large numbers of eggs have been laid and these are now hatching. If the queens were unfertilized the eggs will doubtless, to judge from the analogy of bees and other ants, produce males, which may be very desirable if it should prove possible to breed the insects in captivity.

The queen does not have a special chamber, but walks about among the workers. She was usually found in the lowest chamber of the nest, with eggs and young larvæ, and nearest to the "bone yard," but if the lower chambers of the nest were opened first by digging in from the side, she sometimes took refuge in the upper rooms or perhaps escaped into the open air. In several of the nests no queens were found. In the cages the queens usually remain constantly in the lowest chambers and are fed by the workers. Some queens seem, however, to have more of the instincts of workers, and one or two regularly come to the surface to feed with them. In one instance a worker was seen carrying a queen about the nest. She had been seized by the jaws and her body was waving in the air over the worker's back. It was feared at first that she was dead, but on being released her actions were normal.

At Victoria some of the colonies were released by placing the jar on the ground and inserting a bent cotton stalk on which the insects could climb out. They immediately began digging a burrow at the base of the adjacent cotton plant, and in the course of two hours the workers were ready for the queen and a delegation of two or three of them brought her out. She returned several times to the underground chambers of the cage, but was finally aroused sufficiently to follow along the cotton stalk and out of the jar. The eggs and larvæ had already been removed. One of the queens did not go directly into the ground, but climbed the cotton plant and remained there about an hour, in spite of many visits from workers who caressed her with their antennæ as though to coax her to come down. In some instances the queen remained longer in the old nest and was not transferred till night, when the colonies seem to be quite as active as in the daytime, perhaps more so. On another occasion the queen was carried bodily into the new nest by a worker who seized her by the mandibles, as mentioned above.

The very strong homing instinct of the ants would have made it safe to release them in the plantations for study, even if their other

habits had been less known. Instead of scattering or becoming bewildered under the strange conditions they act from the first as though they were thoroughly familiar with their surroundings. Many colonies have been tested on a table isolated below by water. The insects were allowed to climb out of their cages by means of a ladder consisting of a cotton leaf with the stem bent back. There was no hesitation or preliminary exploration. The ants filed out at once and spread themselves over the table. Weevils were often caught, stung, and carried back to the cage within a minute or two after the release of the ants from their captivity.

All observations continue to confirm the previous report, that this ant is a truly predaceous insect. Compared with the nervous haste of many other species, its motions are slow and deliberate, and, like the so-called praying mantis, it stands for long periods quite motionless, with its antennæ and mandibles extended, ready for something to come that way and be caught. It seldoms attacks weevils or other insects unless they are in motion and a weevil is generally safe as long as it keeps quite still. The ant's field of vision seems limited to less than an inch. This, however, is adequate for practical purposes, since the most convenient time for catching the weevil is when it is climbing up the plant. In Guatemala a weevil placed on a leaf stem so as to walk up and meet an ant was almost sure to be taken. In that country, however, weevils are seldom or never seen crawling about on the cotton, perhaps because the ants have discouraged this habit; but Mr. Hunter informs me that in Texas the weevils frequently reach the bolls by climbing up from the ground, and that they usually pass along the stems from one square or boll to another, so that the opportunities of the ants are excellent.

That the ants know how to sting the weevils at the only two points where their armor is vulnerable shows, of course, a highly specialized instinct, and it is altogether likely that all individuals do not possess it in an equal degree. Some colonies, too, attack the weevils much more promptly and skillfully than others. As might naturally be expected, hunger increases the eagerness and adroitness of the insects, and it seems, too, that the members of the large colonies show more ferocity than those of the small, as is known to be the case with the honey bee and many other social animals. The imported colonies contain from twenty to one hundred and ten workers each, averaging between forty and fifty. It may be that the smaller communities and their queens would survive in captivity as long or longer than the larger colonies, but if it should appear that they are less able to forage successfully the desired increase in numbers may be much slower, so that the use of larger cages and the bringing of larger colonies may prove desirable, should further importations of the ants be made. The rate of propagation of the keleps is likely to prove much slower

than that of the weevils, but the ants are such long-lived insects that they may be expected to overtake the weevils under favorable conditions. An ant queen has been known to live for fifteen years and a worker for six years.

The fact that the ants attack, paralyze, and destroy the weevils has been assumed frequently to mean that a battle takes place between the insects, and pictures of such imaginary encounters have appeared in the newspapers. As a matter of fact, however, the weevil has no means of defense except its armor and is quite at the mercy of any ant strong and skillful enough to sting it. Even this stinging is not always necessary, some weevils being carried into the nest without being stung, and perhaps while still feigning death to avoid discovery. The ants are strong enough to pull the weevils in pieces, but the preliminary sting facilitates matters by preventing any further efforts at escape. It is a well-known fact that insects and spiders which have been stung and paralyzed by predaceous wasps as food for their young will keep for considerable periods. The ants may utilize this means of storing food when there is an overabundance; a colony fed for the last three days exclusively on weevils kills more than it consumes, and piles up the victims.

The fact that the ant uses its sting in capturing its prey has led some to confuse it with the stinging ants which are serious pests in some tropical countries. Some of these inflict painful injuries and are much feared. There is, for example, an ant which makes nests among the leaves of the coffee trees in Liberia, rendering it quite impracticable to gather the crop until the insects are dislodged by fire. The kelep does not belong, however, to any such category. It is a predaceous or hunting ant which very seldom stings except to paralyze its prey and thus render the game easier to capture and carry off; but at other times it has no inclination to sting and does so only when actually seized or injured. The sting, however, is too small and weak to penetrate the skin of the inside of the hand, so that the insects can be picked up with entire impunity. If accidentally squeezed between the fingers or caught under one's collar, a kelep may be able to sting, but the wound smarts, in most people, for only a few minutes, and is on the whole a less formidable injury than a mosquito bite, since the irritation is less prolonged.

It should be a sufficient testimony to the peaceable temper of the ants to state that in opening about 100 nests and collecting some 4,000 ants Mr. Doyle and I were stung only about half a dozen times, and that with no care or precautions. A majority of the ants were picked up with the bare hands while the disturbed insects crawled at liberty over us. Under such circumstances a stinging ant would attempt to wound any foreign object which came in its way, but the keleps have apparently no tendency to defend their nest in this manner.

They are not afraid to climb upon the hand if one stands still, but they appear to do this out of curiosity, and not to fight; and, as already stated, they never attempt to sting human beings unless actually held or injured. The fear that they may interfere with the cultivation of the cotton or with the harvesting of the crop is entirely groundless. It would be much more nearly correct to compare them with a harmless insect-eating animal like the toad than with the vegetable-feeding, stinging ants, like the large red ant so common about Victoria. This latter species has a vicious temper, seeks actively to sting the intruder, and is able to inflict a serious, painful wound, accompanied by nausea, headache, fever, and even temporary paralysis. Fortunately, the cotton ant is able, by its superior dexterity, to defend itself, and is always victorious in a struggle with the harmful Texan species, the extermination of which would be almost as welcome at Victoria as the destruction of the boll weevil itself.

The Indians believe that the keleps are able to combat also the dreaded *teken* or leaf-cutting ants which are as serious pests in Guatemala as in southern Texas. It is scarcely to be supposed, perhaps, that they can drive out well-established communities of the leaf-cutters, but they may prevent the growth of new colonies by killing the workers as fast as they appear above ground. At least there are no nests of leaf-cutters in the areas occupied by the keleps.

The fact that the ants were fed on sugar during the journey from Guatemala to Texas has suggested to some planters that the insects may escape from the cotton plants and attack cane. This apprehension is also quite unnecessary. The moistened sugar was used merely as the most readily obtainable substitute for the nectar secreted for the ants by the cotton plant. The ant's jaws are especially adapted for catching the weevils or other insects, but are quite unsuited for gnawing into sugar cane or other vegetable tissues. They are too long, blunt, and weak to be effective for biting, and are used only for seizing, carrying, and pulling apart their prey. They do not crush nor chew their food, and are apparently unable to eat anything except liquids or substances soft enough to be lapped up, as it were, by their tongues. While the insects are feeding, their jaws are usually opened wide as though to get them out of the way. The strong front legs are used in much the same manner as the squirrel's paws, to assist the jaws in grasping and turning the prey, though they serve also for walking.

None of the numerous varieties of cotton growing at Victoria has nectaries equal in size to those of the Guatemalan cotton protected by the ants, but the quantity of liquid food available in fields of such varieties as King and Parker may prove sufficient, the average size of cotton plants in Texas being much larger than in Guatemala. More

ants will be necessary, however, for their protection, and the nectar-producing qualities of the different varieties may become a question of practical importance if the keleps should become established. At present the nectar secreted on the leaves and "squares" of the cotton goes to waste, or even serves to attract injurious insects, among them the bollworm moth. The discovery of the ant supplies a practical reason for the existence of the nectaries, hitherto quite unsuspected, and it suggests the further possibility that the weevil and the ant may have been factors in the evolution of the cotton plant, for the weevil is not known to feed on any plant except cotton.

The former report alludes to the scarcity of insects in the cotton fields protected by the keleps, but it had not at that time been ascertained that these ants were a cause of the deficiency. The finding of the bone yards filled with the disjointed remains of their prey proves that they capture and consume adult insects of many and diverse kinds, and at Victoria they have shown a taste for bollworms also and similar soft-bodied larvæ. Their appetites are not, however, without discrimination. They have spared, for example, the larvæ of ladybirds, which are beneficial insects; also those of the small Thecla butterfly, which is sometimes injurious to cotton. The former are often picked up by the keleps but are put down again without injury, while the latter are fondled and licked with the tongue. The keleps sometimes visit plant-lice and leaf-hoppers to secure honeydew, but they have not been detected in taking care of these insects or in carrying them about, as do many other ants. This is the only suggestion of an undesirable propensity on the part of the keleps, but the danger, if any, is extremely remote—much less, indeed, than with many ants native in the United States.

SUMMARY.

The present status of the investigation of the boll-weevil ant may be summarized by saying that three of five crucial questions have been met and answered, and that two others are still to be reached, but with no insurmountable obstacles as yet in sight.

(1) **An ant has been discovered in Guatemala which attacks and kills the adult boll weevil, and thus holds this most injurious insect in check and permits the regular harvesting of a crop of cotton, even under conditions favorable to the weevil.**

(2) **This ant is carnivorous and predaceous; it injures no form of vegetation, and takes nothing from the cotton plant except the nectar secreted for it on the leaves and floral envelopes.**

(3) **The habits and temperament of the insect are such that it is readily capable of domestication, transportation, and colonization in the cotton fields of Texas.**

The issues which remain to be determined are:

(4) Whether the keleps will survive the winter climate of Texas; and,

(5) Whether they can be obtained or propagated in sufficient numbers to serve the practical purpose for which they have been introduced.

It would be most unfortunate, however, if the discovery of what may prove to be an effective enemy of the boll weevil should result in any premature relaxation of efforts to avoid damage by cultural expedients. Indeed, it seems quite possible that the first use of the ant may be to render such measures more effective, since while still limited to small areas the keleps may be able to perform an important service if they can still further reduce the number of weevils which survive the winter. If the cotton plants close about the nests of the ants were allowed to remain through the winter, the weevils would congregate upon them and thus furnish the food which the ants are likely to require on warm days of the colder months.

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